

Table 1-1
Status of Site Areas

Area	Remedial Investigation Characterization (1992-1993)	Interim Source Removal (1990-1993)	Additional Characterization (1999-2002)	Additional Interim Source Removal (1999-2002)
1/2/3/4	X	X	X	X
5		X	X	X
6	X	X		X
7	X		X	X
8		X		X
10	X	X	X	X
11	X			X
12	X			
16	X			
18	X	X	X	X
19		X	X	X
20		X		X
22 (AP-B)	X	X		X
23 (AP-G)	X			
24A	X	X		X
25	X	X	X	X
26	X	X	X	X
30		X		X
31	X	X	X	X
35		X		
36		X	X	X
38	X	X	X	X
39		X	X	
AP-A	X			
AP-C	X			X
AP-D	X			
AP-E	X			
AP-F	X		X	X
Site Reference	X		X	X
Historical RR Grades	X		X	X
Sequalitche Creek NGRR	X		X	X
Miscellaneous			X	X

Notes:

Areas 20 and 40 (Parcel 2) achieved No Further Action status in 1993 and 1996, respectively.

Areas 15 and 32 within the CDB underwent Independent Cleanup Actions (1981 to 1988).

Areas outside the CDB that are/will be the subject of other reports: 9, 13, 14, 17, 21, 24B, 27, 28, 29, 33, 34, and 37.

Areas outside the CDB that underwent Independent Cleanup Actions (1981 to 1988): 9, 21, 27, 28, 29, and 33.

Areas outside the CDB that achieved No Further Action status: 21, 27, 28, and 29.

CDB - Consent Decree Boundary

NGRR - Narrow Gauge Railroad

RR - railroad

Table 2.2-1
Summary Statistics of Soil Quality in Area Background Samples

Metal (total) in mg/kg	Range of Concentrations	Maximum Detection	Detection Frequency	Arithmetic Mean	Arithmetic Std. Dev.	Nat. Log. Mean	Nat. Log. Std. Dev.
Aluminum	11,000 to 33,000	33,000	13/13	19,462	6,936	9.82	0.34
Antimony	0.28 U to 3	3	9/13	1.1	0.8	-0.35	0.92
Arsenic	9.1 to 36	36	20/20	20.7	7.6	2.96	0.40
Beryllium	0.22 to 0.42	0.42	10/10	0.29	0.07	-1.25	0.22
Cadmium	0.22 J to 1.2 J	1.2	10/10	0.60	0.3	-0.66	0.59
Chromium	8 to 24	24	13/13	15.5	4.5	2.70	0.29
Copper	15 to 33	33	10/10	22.5	7.4	3.06	0.33
Lead	6.4 U to 57	57	12/13	28.2	16	3.05	0.76
Mercury	0.083 U to 0.2	0.2	3/10	0.17	0.06	-2.66	0.63
Nickel	11 to 22	22	10/10	16.6	3.6	2.79	0.24
Selenium	0.29 U to 0.34 J	0.34	1/10	0.34	0.06	-1.77	0.25
Silver	0.04 J to 0.12	0.12	10/10	0.08	0.03	-2.67	0.43
Thallium	0.29 U to 0.35 U	N/A	0/10	N/A	0.01	-1.85	0.06
Zinc	27 to 54	54	13/13	38.4	7.6	3.63	0.20
Explosives in mg/kg							
Monomethylamine nitrate	5.9 U to 7.6 U	N/A	0/10	3.16	0.26	1.15	0.08
Nitroglycerine	0.24 U to 0.31 U	N/A	0/10	0.13	0.01	-2.06	0.08
Nitrobenzene	0.07 U to 0.091 U	N/A	0/10	0.04	0.00	-3.29	0.08
1,3-Dinitrobenzene	0.047 U to 0.061 U	N/A	0/10	0.03	0.00	-3.68	0.08
1,3,5-Trinitrobenzene	0.035 U to 0.046 U	N/A	0/10	0.02	0.00	-3.97	0.08
2,4-Dinitrotoluene	0.0071 U to 0.0092 U	N/A	0/10	0.00	0.00	-5.58	0.08
2,6-Dinitrotoluene	0.0071 U to 0.0092 U	N/A	0/10	0.00	0.00	-5.58	0.08
2,4,6-Trinitrotoluene	0.0035 U to 0.0046 U	N/A	0/10	0.00	0.00	-6.27	0.08
PAHs (noncarcinogenic) in mg/kg							
Acenaphthene	0.2 U to 0.46	0.46	1/10	0.14	0.11	-2.10	0.47
Acenaphthylene	0.2 U to 0.25 U	N/A	0/10	0.11	0.01	-2.25	0.07
Anthracene	0.0099 U to 0.013 U	N/A	0/10	0.01	0.00	-5.24	0.09
Benzo(g,h,i)perylene	0.02 U to 0.025 U	N/A	0/10	0.01	0.00	-4.55	0.07
Fluoranthene	0.02 U to 0.025 U	N/A	0/10	0.01	0.00	-4.55	0.07
Fluorene	0.02 U to 0.025 U	N/A	0/10	0.01	0.00	-4.55	0.07
Naphthalene	0.099 U to 0.13 U	N/A	0/10	0.05	0.00	-2.94	0.09
Phenanthrene	0.0099 U to 0.013 U	N/A	0/10	0.01	0.00	-5.24	0.09
Pyrene	0.02 U to 0.025 U	N/A	0/10	0.01	0.00	-4.55	0.07
PAHs (carcinogenic) in mg/kg							
Benzo(a)anthracene	0.02 U to 0.025 U	N/A	0/10	0.01	0.00	-4.55	0.07
Benzo(a)pyrene	0.02 U to 0.025	0.025	1/10	0.01	0.00	-4.47	0.28
Benzo(b)fluoranthene	0.02 U to 0.025 U	N/A	0/10	0.01	0.00	-4.55	0.07
Benzo(k)fluoranthene	0.02 U to 0.025 U	N/A	0/10	0.01	0.00	-4.55	0.07
Chrysene	0.01 U to 0.16	0.16	7/10	0.04	0.05	-3.63	1.02
Dibenz(a,h)anthracene	0.04 U to 0.052 U	N/A	0/10	0.02	0.00	-3.84	0.08
Indeno(1,2,3-c,d)pyrene	0.02 U to 0.025 U	N/A	0/10	0.01	0.00	-4.55	0.07
TPH in mg/kg							
TPH (418.1)	24 U to 31 U	N/A	0/10	12.75	1.06	2.54	0.08
Semi-volatile organics in mg/kg							
bis(2-Ethylhexyl)phthalate	0.043 J to 0.71	0.71	4/11	0.15	0.19	-2.21	0.68
	No other constituents detected above detection limit						
Volatile organics in mg/kg							
PCBs in mg/kg	No constituents detected						
Organochlorine pesticides in mg/kg	No constituents detected						
Organophosphorus pesticides in mg/kg	No constituents detected						

Notes:

J - estimated value

mg/kg - milligram per kilogram

N/A - not sufficient detections to calculate

PAH - polycyclic aromatic hydrocarbons

PCB - polychlorinated biphenyl

TPH - total petroleum hydrocarbons

U - not detected a detection limit indicated

UJ - not detected at estimated detection limit indicated

Table 2.2-2
90th Percentile Metals Concentrations in Site Area and Regional Background Samples

	Concentration in mg/kg (ppm)					
	RI Site Area Background ^{a,b}				Puget Sound ^c	Northern Puget Sound ^d
	n-censored	n-uncensored	Mean	90th %		
Aluminum	0	13	19,462	29,498	32,600	
Antimony	2	11	1.1	2.5		0.62
Arsenic	0	20	21	33	7.0	
Beryllium	0	10	0.29	0.39	0.6	
Cadmium	0	10	0.60	1.2	1.0	
Chromium	0	13	16	22	48	
Copper	0	10	23	33	36	
Lead	1	12	28	51	24	
Mercury	7	3	0.17	0.20	0.07	
Nickel	0	10	17	22	48	
Selenium	10	1	0.34	0.32		0.34
Silver	0	10	0.08	0.13		0.5
Thallium	10	0	N/A	N/A		9.8
Zinc	0	13	38	49	85	

^aSource: Hart Crowser 1987 and current study

^bSource: Hart Crowser 1987 and current study

^cSource: Ecology 1994

^dSource: Harper & Owes 1985; METRO (unpublished)

^eSource: Shacklette & Boerngen 1984

Notes:

mg/kg - milligram per kilogram

PPM - parts per million

RI - remedial investigation

Table 3.1-1
Summary of Hydraulic Conductivity (K) Estimates

Water Table Aquifer		
Site-Specific Data:		
<u>Well No.</u>	<u>Method</u>	<u>Estimated K in cm/sec</u>
MW-12	Short-term pumping test	2×10^{-2}
MW-7	Short-term pumping test	7×10^{-2}
MW-8	Slug test	2×10^{-3}
MW-14	Slug test	1×10^{-2}
MW-22	Slug test	2×10^{-3}
MW-24	Slug test	2×10^{-3}
Various ^a	Grain size data	5×10^{-1} to 4
Regional Data:		
<u>Well No.</u>	<u>Method</u>	<u>Estimated K in cm/sec</u>
City of DuPont No. 1 ^b	Pumping test	4×10^{-3}
PW-1A ^c	Pumping test	9×10^{-3} to 2×10^{-2}
Best Estimate Range ^d for Water Table Aquifer:		5×10^{-3} to 5×10^{-2}
Semi-confined Sea Level Aquifer (East of "Cutoff")		
Site-Specific Data:		
<u>Well No.</u>	<u>Method</u>	<u>Estimated K in cm/sec</u>
MW-18	Slug test	4×10^{-3}
Regional Data:		
<u>Well No.</u>	<u>Method</u>	<u>Estimated K in cm/sec</u>
Bell Hill No. 1 ^e	Pumping test	5×10^{-2}
Bell Hill No. 2 ^f	Pumping test	4×10^{-2}
Weyerhaeuser No. 3 ^b	Pumping test	1×10^{-2}
Fort Lewis No. 18 ^b	Pumping test	6×10^{-3}
Best Estimate Range ^d for Semi-confined Sea Level Aquifer:		1×10^{-2} to 5×10^{-2}
Unconfined Sea Level Aquifer (West of "Cutoff")		
Site-Specific Data:		
<u>Well No.</u>	<u>Method</u>	<u>Estimated K in cm/sec</u>
MW-2	Slug test	3×10^{-3}
MW-4	Slug test	2×10^{-3}
MW-6	Slug test	4×10^{-2}
MW-16	Slug test	2×10^{-2}
Various ^a	Grain size data	2×10^{-1} to 1
Regional Data:		
<u>Well No.</u>	<u>Method</u>	<u>Estimated K in cm/sec</u>
None ^c	Literature review	4×10^{-1} to 4
Best Estimate Range ^d for Unconfined Sea Level Aquifer:		1×10^{-2} to 1

Table 3.1-1 (Continued)
Summary of Hydraulic Conductivity (K) Estimates

^aK estimates from grain size data are presented in Table 3.1-2.

^bFrom Associated Earth Sciences 1984.

^cFrom Woodward-Clyde Consultants 1990.

^dThe Best Estimate Range represents the best estimate of the reasonable range of aquifer K values based on all available data.

^eFrom Hart Crowser 1988b.

^fPumping test conducted in Bell Hill No. 1 during drilling of Bell Hill No. 2 to deeper aquifer (from Hart Crowser 1990).

Note:

cm/sec - centimeter per second

Table 3.1-2
Hydraulic Conductivity (K) Estimates Based on Application of Kozeny-Carmen
Equation to Grain Size Data

Sample No.	Sample Description From Grain Size	d50 in cm	Estimated K in cm/sec assuming	
			porosity = 0.2	porosity = 0.35
Water Table Aquifer				
MW-13, S-3	Slightly silty, very sandy GRAVEL	0.7	3	24
MW-20, S-17	Very gravelly SAND	0.178	0.2	2
MW-21, S-17	Slightly silty, very sandy GRAVEL	0.484	1	11
MW-22, S-20	Slightly silty, very sandy GRAVEL	0.807	4	32
MW-24, S-11	Slightly silty, very sandy GRAVEL	0.383	0.9	7
Geometric Mean of Values:			1.2	10
Unconfined Sea Level Aquifer (West of Cutoff)				
MW-4, S-8	Gravelly SAND	0.1	0.06	0.5
MW-5, S-8	Slightly silty, gravelly SAND	0.3	0.5	4
Geometric Mean of Values:			0.2	1

Notes:

Grain size data for wells MW-20 through MW-24 presented in Appendix D.

Grain size data for MW-13, MW-4, and MW-5 from Hart Crowser 1988a.

Kozeny Carmen Equation is $(pg/1.8\mu) * (d50)^2 * [n^3/(1-n)^2]$ (Freeze and Cherry 1979),
 where p = density of water in kg/m³; g = gravitational acceleration in m/sec²; 1.8 is units correction factor;
 n = porosity; d50 is median grain size in cm. At 15°C, pg/1.8μ is 478 cm⁻¹sec⁻¹.
 cm/sec - centimeter per second

Table 3.1-1 (Continued)
Summary of Hydraulic Conductivity (K) Estimates

^aK estimates from grain size data are presented in Table 3.1-2.

^bFrom Associated Earth Sciences 1984.

^cFrom Woodward-Clyde Consultants 1990.

^dThe Best Estimate Range represents the best estimate of the reasonable range of aquifer K values based on all available data.

^eFrom Hart Crowser 1988b.

^fPumping test conducted in Bell Hill No. 1 during drilling of Bell Hill No. 2 to deeper aquifer (from Hart Crowser 1990).

Note:

cm/sec - centimeter per second

Table 3.2-1
Summary of Groundwater Sampling (by Location) Conducted to Date

Sampling Location	Pre-RI								RI										
	Dec-86	Mar-88	Jun-88	Oct-88	Jan-89	Nov-89	Aug-90	Mar-92	Jun/Jul-92	Sep-92	Dec-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94
MW-1		X	X	X	X	X	X	X	X	X	X								
MW-2		X	X	X	X			X	X	X	X								
MW-3		X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X
MW-4		X	X	X	X			X	X	X									
MW-5		X	X	X	X			X	X	X									
MW-6		X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X
MW-7		X	X	X	X			X	X	X									
MW-8		X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X
MW-9		X	X	X	X			X	X	X									
MW-11		X	X	X	X			X	X	X									
MW-12		X	X	X	X			X	X	X									
MW-13		X	X	X	X		X	X	X	X									
MW-14		X	X	X	X			X	X	X									
MW-15		X	X		X	X	X	X	Dry	X	X	X	X	X	X	X	Dry	Dry	
MW-16		X	X	X	X			X	X	X									
MW-17	Dry				X	X	X	X	X	X									
MW-18						X	X	X	X	X									
MW-19						X	X	X	X	X		X	X	X	X	X	X	X	X
MW-20								X	X	X									
MW-21								X	X	X									
MW-22								X	X	X		X	X	X	X	X	X	X	X
MW-24								X	X	X									
MW-26									X	X	X								
MW-27									X	X	Dry	X	X	X	Dry	X	X	Dry	Dry
7-B-503									X										
SEEP 1						X	X	X	X	X	X		X	X	X	X	X	X	X
SEEP 2						X	X	X	X	X	X								
SPR-4	X	X	X	X	X			X	X	X	X								
W-1																			
W-2																			
W-3															X				

Table 3.2-1 (Continued)
Summary of Groundwater Sampling (by Location) Conducted to Date

Sampling Location	RI															
	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	Jun/ Jan-97	Apr-97	Jul-97	Oct-97	Mar-98	Mar-99	Mar-00	Mar-01
MW-1																
MW-2																
MW-3	X	X	X	X	X	X	X	X	X	X	X	X	X	Dry	X	X
MW-4																
MW-5																
MW-6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW-7																
MW-8	X	X	X	X	X	X	X	X	X	X	X					
MW-9																
MW-11																
MW-12																
MW-13																
MW-14																
MW-15	X	X	Dry	Dry	X	X	Dry	Dry	X	X	Dry	Dry				
MW-16																
MW-17																
MW-18																
MW-19	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW-20																
MW-21																
MW-22	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW-24																
MW-26																
MW-27	X	X	Dry	Dry	X	Dry	Dry	Dry	X	Dry	Dry	Dry				
7-B-503																
SEEP 1	X	X	X	X	X	X	X	X	X	X	X					
SEEP 2																
SPR-4																
W-1		X			X	X	X	X	X	X	X					
W-2		X			X	X	X	X	X	X	X	X	X	X	X	X
W-3					X											

Notes:

RI - remedial investigation

X - location sampled

Table 3.2-2
Number of Usable Data Points (Analyses) for Each Groundwater Sampling Location

Location	Nitrate	Total Lead Only	14 Total Metals	Dissolved Lead Only	14 Dissolved Metals	NAX	NG	MMAN	TPH	PAHs	PCBs	OC Pesticides	OP Pesticides	VOCs	SVOGs
MW-1	10		4	4	4	8	6	7	4	4				[3]	
MW-2	8		4	3	4	6	4	5	4	4	4	4	4	4	4
MW-3	9		4	3	4	29	5	6	4	4	4	4	4	6	4
MW-4	8		4	3	4	6	4	5	4	4	4			[1]	
MW-5	8		4	3	4	6	4	5	4	4	4	4	4	[1]	
MW-6	10		4	3	4	30	5	6	4	4				[2]	
MW-7	8		4	3	4	6	4	5	4	4	4			[1]	
MW-8	9	2	4	3	4	26	5	6	4	4	4			4	4
MW-9	8		4	3	4	6	4	5	4	4				4	4
MW-11	9		4	3	4	6	4	5	4	4				4	4
MW-12	9		4	3	4	6	4	5	4	4		4	4	4	4
MW-13	10		4	3	4	7	5	6	4	4				[2]	
MW-14	8		4	3	4	6	4	5	4	4				[1]	
MW-15	9	1	4	3	4	18	4	5	3	4	2			4	2
MW-16	9	2	4	4	4	7	5	6	4	4	4			5	4
MW-17	5		4	1	4	7	5	5	4	4				[2]	
MW-18	6		4	1	4	6	4	4	4	4				[2]	
MW-19	6		4	1	4	30	4	4	4	4	4			[2]	
MW-20	4		4		4	4	4	4	4	4					
MW-21	4		4		4	4	4	4	4	4					
MW-22	4		4		4	28	4	4	4	4					
MW-24	4		4		4	4	4	4	4	4	4				
MW-27	2		1			2	12	2	2	1	1				
7-B-503	0		1		1	1	0	0	0	0	1				
SEEP 1	6	1	4	1	4	25	4	4	4	4	4				
SEEP 2	6		4	1	4	6	4	4	4	4	4				
SPR-4	9	1	4	3	4	6	4	5	4	4				4	4
W-1						7									
W-2						13									
W-3						2									

Notes:

Blanks indicate constituent was not proposed for analysis at that sampling location in the RI/FS Management Plan.

Numbers in brackets [] are usable data points for constituents not proposed for analysis in RI/FS Management Plan, but analyses were conducted.

Total number of total or dissolved lead analyses are equal to the sum of the lead only (pre-RI) and 14 metals (RI) numbers of analyses.

Table 3.2-2 (Continued)
Number of Usable Data Points (Analyses) for Each Groundwater Sampling Location

FS - feasibility study
MMAN - monomethylamine nitrate
NAX - nitroaromatic explosives
NG - nitroglycerine
OC - organochlorine
OP - organophosphorus
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
RI - remedial investigation
SVOC - semivolatile organic compound
TPH - total petroleum hydrocarbons
VOC - volatile organic compound

Table 4.1-1
Number of Usable Data Points (Analyses) for Each Surface Water Sampling Location

Location	Nitrate	Total Lead Only	14 Total Metals	Dissolved Lead Only	14 Dissolved Metals	NAX	NG	MMAN	TPH	PAHs	PCBs	VOC Pesticides	OP Pesticides	VOCs	SVOCs
Sequalitchew Creek															
SW-3	4	1	4	2	4	6	4	5	4	4		[1]		[1]	[1]
SW-4	2	1	2	2	2	3	3	4	2	2		[1]		[1]	[1]
Old Fort Lake															
SW-5	4	1	4	2	4	6	4	5	4	4				[1]	[1]
SW-6	4	1	4	2	4	6	4	5	4	4				[1]	[1]
SW-7	4	1	4	2	4	6	4	5	4	4				[1]	[1]

Notes:

Blanks indicate constituent was not proposed for analysis at that sampling location in the RI/FS Management Plan.

Numbers in brackets [] are usable data points for constituents not proposed for analysis in RI/FS Management Plan, but analyses were conducted.

Total number of total or dissolved lead analyses are equal to the sum of the lead only (pre-RI) and 14 metals (RI) numbers of analyses.

FS - feasibility study

MMAN - monomethylamine nitrate

NAX - nitroaromatic explosives

NG - nitroglycerine

OC - organochlorine

OP - organophosphorus

PAH - polycyclic aromatic hydrocarbon

PCB - polychlorinated biphenyl

RI - remedial investigation

SVOC - semivolatile organic compound

TPH - total petroleum hydrocarbons

VOC - volatile organic compound